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How Community Matters for User Innovation: The "Open Source" of Sports Innovation

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0.0 Abstract

This exploratory study analyzes the context within which end-users develop sports-related consumer product innovations. We find that end-user innovators who are members of voluntary special-interest user communities often receive assistance in developing their innovations from fellow community members. Within these user communities, we find that innovation-related information and assistance, as well as the innovations themselves, are freely shared. The processes by which these voluntary user innovation communities operate and the "institutional" structure supporting innovation and free sharing of innovations may be of general interest both within and beyond the consumer products arena. Communities of open source software developers, for example, appear to operate in very similar ways.

1.0 Introduction

Academics and practitioners alike express interest in uncovering, explaining, and potentially manipulating the sources of innovation. A great deal of research has focused on product development, research and development, and other innovative activities within firms. However, research has shown that many important industrial product and process innovations are developed within firms where the product is used, rather than by firms who manufacturer the product for sale to others (von Hippel, 1988). Furthermore, two recent studies focus on innovation in consumer markets and show that end-users not only innovate, but they also make key innovations in their field (Luthje, 2000; Shah, 2000). How these end-users obtain the resources and information necessary to develop their innovations is a research-worthy puzzle given the prevalence (Luthje, 2000) and importance (Shah, 2000) of the end-user innovations studied to date.

In this paper, we report the results from the first study of the context surrounding end users who innovate in consumer products. The users we study are members of one of the four communities of sports enthusiasts we surveyed and report having developed a novel sporting equipment innovation. Our focus is on how end users obtain the necessary resources to develop their innovations. We find that, without exception, these users do not innovate in isolation or secrecy.

Rather, they innovate within a voluntary user community, such as a sporting club, and receive important advice and assistance from other community members. Assistance was provided to innovators for free and innovators generally shared their innovations to the community for free - although the levels of free support and access diminished somewhat as competitive pressures grew higher. Monetary profit was not a key motivator for either innovators or those who assisted them; instead, survey respondents cited having fun and viewing the giving of innovation-related assistance to community members as a social norm as the strongest factors influencing their decision to assist innovators. The data indicates that a system built around the principal of generalized exchange, rather than a purely individualistic system focused on personal benefits alone, is at work in understanding why community members assist each other in innovating. Receiving assistance appears to be a necessary, but not sufficient input into creating an innovation that will diffuse widely.

We propose that the phenomenon we report upon - innovation by end users within voluntary user communities - is a general and widespread phenomenon worthy of further study. The context in which the user-innovators in consumer product fields studied here innovate may serve as the functional equivalent of the multi-person innovation project teams often organized by firms to develop novel products and processes. This setting also appears to be quite similar to the context in which open source software is developed. In the open source software context, individual programmers create and improve software within multi-person "project" groups; in doing so they receive free assistance from others and freely share the product of their innovative efforts.

In the following sections of this paper, we review the related literature (section 2), describe our research sample (section 3), and explain our research methods (section 3). Next, we report our findings with respect to the number of innovators in our sample and the types and degree to which they developed their innovations (section 4). Next we report upon our findings regarding the characteristics of individual innovators and the way they interact with other community members and the types of assistance received by innovators and the characteristics of those who give this assistance (section 5). We then discuss what may be motivating this behavior; and suggest that a system of generalized exchange appears to be at work in regulating behaviors related to the exchange of information and assistance, and the free-revealing of innovations (section 6). We then discuss how receiving assistance impacts the extent of innovation diffusion (section 7). Finally, we discuss the implications of our findings (section 8).

2.0 Background and Literature Review

2.1 The Sources of Innovation

Empirical research into the "functional" sources of innovation for industrial products and processes has shown that the actual developers of many industrial products and processes, which are often later produced and sold by manufacturers, are users. User-innovators are defined as individuals or firms or other entities that expect to benefit from their innovations by direct use. Manufacturer-innovators are defined as individuals or firms or other entities that expect to benefit from their innovations by selling them to others (Enos 1962, Knight 1963, Freeman 1968, Shaw 1985, von Hippel 1988). Studies continue to uncover the prevalence and importance of user innovations in industrial products (von Hippel, 1988; Riggs and von Hippel, 1994; Morrison, et al, 2000; others) and methods by which to "harness" this innovative ability (von Hippel, 1986; Herstatt and von Hippel, 1992; Morrison, et al, 2000; von Hippel et al, 2000).

The existing literature on user innovation focuses primarily on innovation in industrial products. Two studies have begun the exploration of the user phenomenon in consumer markets, showing that users innovate (Lüthje, 2000; Shah, 2000) and that users make key innovations in their field (Shah, 2000). These studies indicate that users sometimes work together when developing their innovations and share innovation-related information (Shah, 2000) and user-innovators talk to other sportsman significantly more often than do non-innovating users (Lüthje, 2000). It appears that the exchange of information and assistance plays an important role in supporting user innovation; a better understanding of these processes is needed.

While an individual may come up with an innovative idea, realizing this idea and converting it into a functioning prototype is likely to be difficult. We believe end-user innovators, like their counterparts in firms, are likely to require the assistance of others in developing their innovations. Much research has focused on the provision of resources in product development organizations (Brown and Eisenhardt, 1995); inter- and intra- firm product development-related communications (Allen, 1971, 1984; Ancona and Caldwell, 1992); and even on the emergence of informal "skunk works" within the formal organization. The innovations in consumer products studied by Shah were made by end-users who had no formal organizational structure or resources from which to draw; however there is some evidence that they often received assistance from

and worked closely with others with whom they practiced the sport. For this reason, we study innovations made by members of communities of sports enthusiasts. This study is the first to explicitly examine how user-innovators gather the information and assistance they need to develop their ideas.

2.2 Incentives to Share Innovative Information

Past research on information trading and sharing between rival firms offers limited insight into what types of information and assistance may be exchanged between user-innovators and why. Work on informal information trading argues and empirically demonstrates that, under certain conditions, it makes sense to exchange existing information, even among rivals (von Hippel, 1987; Schrader, 1991). These studies focus on reciprocal exchange relationships where the information exchanged has relatively low competitive value: the rival could obtain this information from other sources or could relatively easily uncover the information himself.

Other studies focus on the free-revealing of information or innovations, where the information or innovation is shared but there is little or no expectation of receiving direct reciprocal benefits in exchange. Allen finds that many production techniques in the nineteenth century were developed by a process called "collective invention" (Allen, 1983). An essential feature of collective invention is the free-revealing of technical information to actual and potential competitors. Allen argues that it is this behavior that allowed cumulative advance and suggests that firms might even desire such behavior. Rosenkopf and Tushman (1998) examine information and knowledge sharing in the context of inter-organizational networks formed by members of voluntary cooperative groups such as task forces, technical committees and standards groups in the flight simulation industry; they find that community networks and technology co-evolve. As we can see, the free-revealing of innovations and information between firms may occur in a variety of settings and contexts. Harhoff et al. (2000) theoretically characterize this behavior and offer four basic incentives to freely reveal innovations: (1) it may induce improvements by others, (2) an advantageous standard might be achieved this way, (3) the absence of rivalry conditions, and (4) expectations of reciprocity and reputation effects. Expectations of reciprocity and the method by which assistance is reciprocated are a central focus of this study. Restricted (or direct) exchange and generalized (or indirect) exchange are the two primary methods of exchange discussed in the existing literature on social exchange

theory (Levi-Strauss, 1949; Emerson 1976; Ekeh, 1974; Gillmore, 1987; Yamagishi & Cook, 1993); we briefly review them below.

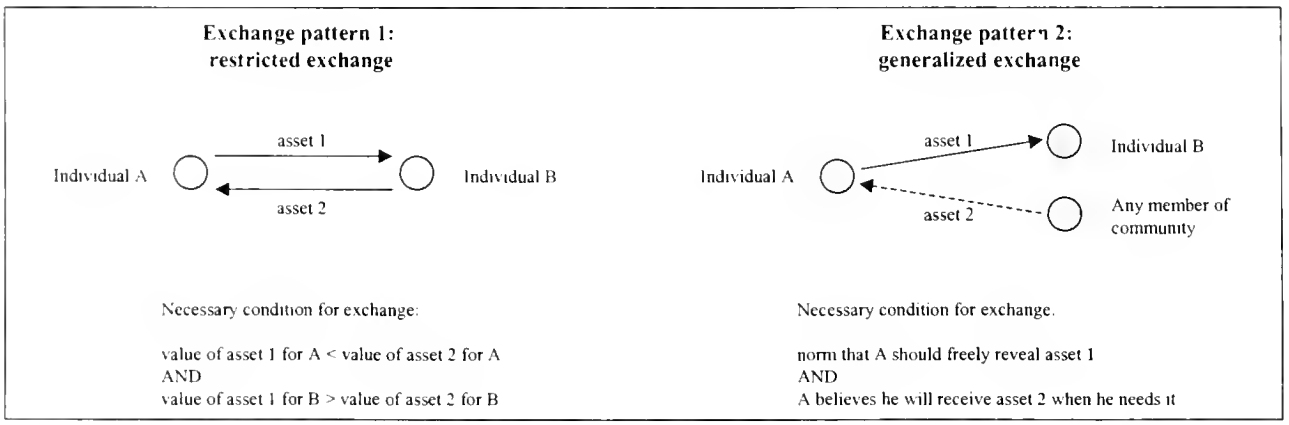
Restricted exchange patterns are discussed in many areas of the academic literature, including sociology (see cites above), economics (Kranton, 1996; Diamond, 1984), and innovation management (von Hippel, 1987; Schrader, 1991). In restricted exchange there are only two parties in the exchange transaction. The two parties trade with each other in the course of the transaction, but their transaction does not include anyone else. The two parties each transact conditionally "A only assists B, if B assists or rewards A." Restricted exchange can be observed in market settings as well as in the context of reciprocal exchange relationships. Market exchange takes place among anonymous agents who generally use money as a medium of exchange (Diamond, 1984)[1]. Reciprocal exchange is an informally enforced agreement to give goods, services, information, or money in exchange for future compensation in kind (Kranton, 1996). Reciprocal exchange is also often referred to as gift exchange by anthropologists who studied reciprocal exchange as a phenomenon prevalent in tribal societies (Sahlins, 1972; Mauss, 1967; Levi-Strauss, 1969).

Generalized exchange involves a different type of "system" in which each individual contributes and receives benefits. In such an exchange relationship, if an individual gives to someone, the giver is generally reciprocated by someone other than who they originally gave to (Ekeh, 1974). To illustrate, imagine that a community member (A) helps another community member (B). In "exchange" for giving assistance to B, A receives assistance from community member C at a later time where C is likely to be better qualified to assist A than is B or other community members. C may later receive assistance from the community member best qualified to assist him (Figure A). For example, a generalized exchange explanation for why stranded motorists receive help from strangers would argue that the person who assists the stranded motorist believes that someone else will help them when they need help in a similar situation, and thus they help the stranded motorist.

While generalized exchange is not conditional, there is an expectation that if a community member provides assistance today, someone else will provide him with assistance when he needs it. In this way the skills of the community members are well used (as they might also be in a

market setting) and both individual community members and the community as a whole benefit. However, from the viewpoint of social exchange, rational choice, or evolutionary theory, the existence of generalized exchange is somewhat of a puzzle because any member of the exchange system can free ride since there is no guarantee of reciprocity (Takahashi, 2000). Therefore, many researchers argue that generalized exchange stems from altruism (Sahlins, 1972) or collective norms (Ekeh, 1974; Levi-Strauss, 1949). A recent article proposes a compelling alternative - a fairness-based selective-giving strategy to these explanations in order to address the free-riding problem: the results of computer simulations show that pure generalized exchange can emerge in a system where each actor selects a recipient whose previous behavior satisfies the actor's own notion of fairness (Takahashi, 2000). The importance of fairness resonates with observations made in studies of on-line and virtual communities: "indeed some observers (Wellman and Gulia, 1999; Rheingold, 1993) have reported that individuals who regularly offer advice and information seem to receive help more quickly when they ask for something (in Kollock, 1999, pp. 227)." Overall, little empirical work on generalized exchange has been conducted (Emerson, 1976; Gillmore 1987), so the relative roles of altruism, norms, and fairness are unclear and a key question remains unanswered: why does generalized exchange emerge and how is it maintained (Takahashi, 2000)? In this article, we argue that a system based on generalized exchange provides the backbone for the innovation-related activities and behaviors we observe.

FIGURE A: Exchange Patterns



[1] This "one-time" exchange pattern may also include rights and include a time-element. For example, an individual could receive a loan from a bank which requires the individual to pay back the principle and interest one year later.

2.3 The Nature of Innovation in Voluntarily Assembled Communities of End-Users

Recently, there has been a surge of interest in open source software (OSS) development, which involves volunteer developers in many different locations and organizations sharing code to develop and refine programs. OSS development has resulted in the creation of software, which may precede, displace, or serve as a substitute for commercially produced software. The similarities between open source communities and sports communities are striking, despite the fact that one community produces physical products and is geographically concentrated, while the other produces software code and is geographically dispersed (von Hippel, 2001). Members of both communities chose to belong to such communities, actively decide whether or not to spearhead or participate in development projects, can at any time to withdraw from or re-enter a community, are community members - not employees, and often participate in the communities for fun (Markus, et al, 2000; Lakhani and von Hippel, 2000).

Members of open source communities innovate and reveal their innovations freely to the community, and freely share information and answer each other's questions. A variety of motivations have been offered for such behavior: some focus on the type of information being shared and opportunities for learning (Lakhani and von Hippel, 2000), others focus on explanations stemming from the labor economics literature on career concerns (Lerner and Tirole, 2000), and other focus on property rights and argue that user-developers are advantageous to firms and markets when products are complex and need to be debugged – even after accounting for free-riding inefficiencies (Besson, 2000). We view open source through the lens of user-innovation and argue in this paper that it is one of many user-communities in which information, assistance, and innovations are freely shared.

The "communities-of-practice" literature (Lave & Wenger, 1991; Brown & Duguid 1991, 2000) provides an interesting parallel to the volunteer communities we study. This literature argues that the ways people actually work usually differs fundamentally from the ways organizations describe that work in manuals, training programs, organizational charts, and job descriptions. This not only misrepresents the actual ways in which people work, but also downplays the significant learning and innovation generated in the informal communities-of-practice in which people actually work (Brown & Duguid, 1991). "Communities of practice" exist in a variety of settings and may develop improvements or innovations in products, services, and work practices:

some documented examples include photocopier repair technicians (Orr, 1996), clerical workers (Wenger, 1998), and radiology technicians (Barley, 1996). The communities-of-practice literature focuses on occupational and organizational communities, while we focus on (innovation in) voluntarily-assembled communities of end-users; however, both literatures question commonly held beliefs about the nature of work, organization, learning, and innovation.

3.0 Study Methods

3.1 Communities Selected for Study

We had two basic criteria for choosing communities for our sample. First, in order to observe community-related innovation behavior, the community as a whole or some community members should be engaged in innovative activities. Second, we wanted to include communities that differed in their make-up (constituency) and structure in order to cover a broad range of community and user characteristics to make for more generalizeable findings. We screened for these criteria by speaking with community leaders and members.

Below you will find a short description of each of the four communities we studied. We are aware of no bias in our innovation pattern findings resulting from the selection of these particular communities.

Sailplaning Community

Sailplaning, which originated in the second half of the 19th century, involves one or two people flying in a (closed) sailplane. The sailplaning community we studied consists of students of technical universities in Germany who share an interest in sailplaning and building their own sailplanes. They spend a great deal of time together and share a common "student" lifestyle.

Canyoning Community

Canyoning is a new extreme sport, which is quite popular in the Alps. It combines mountain climbing, abseiling (rappelling), and swimming in canyons. It is extreme in that it requires significant skill and involves physical risk. Participants do not formally race against each other.

The community we analyzed was established in 1995 with the explicit objective of providing a forum in which to organize joint activities and trips, exchange information, and provide mutual help for people who shared an interest in the new sport. Members organize trips, take part in regular "pub social", make presentations to each other, and maintain a website. A normal trip is likely to involve 25-30 people; each trip generally includes a different combination of community members.

Boardercross Community

"Boardercross" is a new extreme snowboarding sport in which six snowboarders compete simultaneously in a downhill race. Each racetrack varies, but is likely to incorporate tunnels, steep curves, water holes, jumps, etc. The (informal) community we studied consists of semi-professional athletes from all over the world who share an active interest in this sport. They meet in up to 10 competitions a year in Europe, USA/Canada, and Japan. Community members are competitive athletes and compete against one another. They spend a great deal of time together both training and taking part in leisure activities (parties). Community members are very close to one another and share very similar lifestyles.

Handicapped Cycling Community

Individuals with physical disabilities practice many sports; these individuals must often design or make improvements to their equipment to accommodate a variety of physical disabilities. We studied a community of semi-professional cyclists who had cerebral palsy or had had a limb amputated. This community is not a formal club, but community members know each other well from national and international competitions, training sessions, and seminars sponsored by the Deutscher Sportbund (German National Sports Council) for selected athletes. The community is largely comprised of competitive handicapped cyclists who often compete against one another. Although the community members are distributed all over Germany they know each other well and members feel that they are a close community.

TABLE 1: Communities

	Sailplaning	Canyoning	Boardercross (snowboard)	Handicapped Cyclists	Total
Community Characteristics					
Professional level	moderate	moderate	high	high	varies
Location	all over Germany	southern part of Germany	worldwide	all over Germany	varies
Formal ties (e.g. club)	yes	yes	no	no	varies
Level of competition	low	low	high	high	varies
Interaction level	close	close	close	varies	quite close
Relative technical complexity of equipment	very high	low	moderate	moderate	varies
Outside users who might provide information and assistance	e.g. one of the other 552 sailplane clubs in Germany	approx. 1000 at same level in same region	approx. 800 at same level in same region	unknown	many
Average age of respondents (years)	25.1	39.3	22.8	33.5	varies
Percentage of respondents who are female	10.5%	25.6%	48.8%	10.5%	varies (23.1% total)
Sample Characteristics					
Community size (N)	170	123	170	58	521
Response (n)	87	43	48	19	197
Response rate (n/N)	51.1%	35.0%	29.4%	32.8%	37.8%
Innovators as % of respondents	41.4%	30.2%	18.2%	26.3%	32.1%

3.2 Data Collection

After selecting the four communities described above, we conducted several qualitative interviews in order develop a deeper understanding of the role of communities in the innovation process.

We contacted community leaders and questioned them about the best way to contact individual members. As a result, paper questionnaires were mailed to members of the sailplaning, canyoning, and handicapped cyclist communities, while members of the boardercross

community were sent an e-mail describing the nature of the study and containing a link to an on-line version of the questionnaire.

The questionnaires distributed to the different groups contained the same questions and information regarding the study. The questionnaire had four parts. In the first and final parts, all respondents were asked about their personal characteristics as well as their community behavior and attitude. The second part was for innovators only; we asked that the innovator focus on the most important innovation he or she[2] made. The third part of the study was for individuals who had assisted in the development of an innovation only.[3] The questionnaire was anonymous and respondents were assured that their innovative ideas would not be shared with manufacturers. All questionnaires were distributed in December 2000 and after two weeks all respondents were reminded to complete the survey via personal contact, telephone, e-mail, or mail. An overall response rate of 37.8% was obtained.

Despite the high response rate, there is a possibility of self-selection e.g. in favor of innovating users.[4] We have no information about non-respondents, however it has been argued that late respondents who answer only after receiving several reminders are similar to non-respondents (Hendricks, 1949). An analysis of early versus late respondents did not show any significant difference between these two groups. Overall, we are not aware of any bias resulting from either the choice of these four sports communities or from self-selection that influence our findings.

4.0 Findings: The Innovators & Their Innovations

We find that almost a third of the community members in our sample (32.1%) report to have innovated (Table 1); innovation is a relatively common activity within the communities we analyzed. As one would expect many of these innovations were improvements to existing products, but a surprisingly high percentage of innovators created totally new products (Table 2). In this section, we report on these findings, as well as on findings that show that innovators and non-innovators differ significantly in their community-oriented behaviors (Table 3).

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[2] In the remainder of the paper we will use the term "he" and "his" for simplicity, although our sample was comprised of both male and female innovators and non-innovators.
[3] For details see Appendix.
[4] In order to prevent this effect the first section of the questionnaire did not deal with the innovation.

4.1 The Innovations

Over 40% of the innovations reported in our sample solve urgent problems for their innovators and one in seven (14.5%) innovations is considered to be a completely new product by their innovator. Many of the innovators see potential for the sale of their innovation on the mass market and, moreover, almost one-quarter of the innovations are currently or will soon be produced for sale by a manufacturer, and can thus be thought of as having some mainstream or niche market appeal. We asked innovators to provide a short description of their innovations and assess them along several dimensions; the results are shown in Table 2.

Since we asked each innovator to tell us about his most important innovation, (1) the proportion of commercialized or soon to be commercialized innovations, given the complete set of innovations produced by members of these communities, might be overestimated, (2) while the total number of commercialized user innovations might actually be underestimated, since it is possible that some user(s) developed more than one innovation that was subsequently commercialized.

TABLE 2: Characteristics and Examples of User Innovations

Characteristic	Descriptive Statistics			Examples
	Mean	Median	High Agreement	
Newness[a]	3.56	3.5	14.5%	Completely new product: e.g. new emergency system where pilot gets out of the cockpit with a rocket (sailplane)
				Small improvement: e.g. better rucksack (canyoning)
Urgency[b]	4.79	5	41.9%	High urgency: e.g. new brake system for arm-amputated (handicapped cyclists)
				Low urgency: e.g. new ventilation system for cockpit (sailplane)
Market Potential[c]	3.44	4	24.2%	High market potential: e.g. improved boots and binding (snowboard)
				Small market potential: e.g. disrupt fixed rope with chemical (etching) (canyoning)
Commercialization	23.1% of the innovations are currently or will soon be produced for sale by a manufacturer			E.g. new shoe which is seamless, high-frequency welded and offers better protection of the leap joint

[a] self-rating, 7-point rating scale: 1 = small improvement of existing product; 7 = completely new product); n = 60

[b] self-rating, 7-point rating scale: 1 = solves minor problems; 7 = solves acute problems); n = 60

[c] self-rating, 7-point rating scale: 1 = very small; 7 = very big); n = 60

4.2 The Innovators

The way in which an innovator interacts with his community and how he thinks the community perceives him differentiates him from the non-innovator (Table 3). Innovators spend significantly more time with other community members than do non-innovators; specifically they spend 32% (10 days per year) more time per year in the community. In addition, innovators have been members of the community 30% (1.3 years) longer than non-innovators. It appears that time with the community is associated with the likelihood of innovating. This interpretation is supported by the findings that innovators report taking a more active part in the community, partake in more non-sport related activities with other community members, and feel more strongly that the community takes their opinion into account when making decisions than do non-innovators.

These findings alone do not necessarily mean that community has a causal impact on the likelihood of innovation; it could be the case that innovators work in total isolation and developed a reputation for their efforts among their peers, which led to a more central position in the community. Section 5.0 addresses this concern.

TABLE 3: Community-Oriented Behaviors of Innovators vs. Non-Innovators

Characteristic	Innovators[a]	Non-innovators[a]	Difference[b]
Time in Community			
Years as a Community Member	4.46	3.17	$p<0.01$
Days per Year Spent with Community Members	43.07	32.73	$p<0.05$
Days per Year Spent Participating in the Sport	72.48	68.71	n.s.
Role in Community			
"I am a very active member of the community"[c]	2.85	3.82	$p<0.01$
"I get together with members of the community for activities that are not related to the sport (movies, dinner parties, etc.)"	3.39	4.14	$p<0.05$
"The community takes my opinion into account when making decisions"	2.89	3.61	$p<0.05$

[a] all values are means; n = 60/129

[b] t-tests for independent samples

[c] 7-point rating scale: 1 = very accurate; 7 = not accurate at all

5.0 Findings: Innovators Receive Assistance

An individual may develop an idea, but developing this idea into a functioning prototype often requires the assistance of others. We find that user innovation is not an individual task but a joint effort: all the innovators in our sample receive assistance from other individuals during the innovation process; receiving assistance from three to five people is most common (Table 4). Innovators report being very satisfied with the assistance they receive: 79.2% of innovators report that they would ask the same people for help again (Table 4).

In sections 5.1 and 5.2 we show that belonging to a community gives the innovator clear and tangible benefits in obtaining quality innovation-related assistance and that this assistance often comes from other innovative individuals.

TABLE 4: Innovators Receive Assistance and Are Satisfied

Innovators Receive Assistance from:	**Number of Cases**	**%**
0 persons	0	0
1 person	3	6
2 people	14	26
3-5 people	25	47
6-10 people	8	15
Over 10 people	3	6
Total	**53**	**100**

Satisfaction with Assistance Received	**Mean**	**Median**	**High Agreement**	**Low Agreement**
"If I had a similar problem I would ask the same people again" (7-point rating scale: 1 = very accurate; 7 = not accurate at all); n = 53	**1.89**	**2**	**79.2%**	**3.8%**

5.1 Community Membership Helps Innovators Find Assistance

Belonging to a community offers the innovator two key benefits in finding innovation-related assistance: (1) other community members offer assistance directly, and (2) other community members refer the innovator to individuals they know outside of the community.

Specifically, 63.5% of innovators report that belonging to the community helped them find individuals who made contributions to their innovation (Table 5). The most important assistance received was as likely to come from individuals outside the community as it was to come from community members.

We find that 11.4% of the innovators report that the most important information and assistance they received came from individuals who were initially strangers; 32.4% report that this came from individuals who were initially close friends (Table 5). This indicates that community members introduce the innovator to other individuals who may be able to provide assistance - community actively helps the innovator find the assistance he needs and innovators are therefore not "restricted" to working with individuals with whom they have a personal relationship (friendship), have worked with before, or have assisted before.

TABLE 5: Relationships with Those Who Give Assistance

Variable	Mean	Median	High Agreement	Low Agreement
Community Membership Helps in Finding Assistance ("Belonging to the community helped me find people who contributed to my idea/improvement"; 7-point rating scale: 1 = very accurate; 7 = not accurate at all); n = 52	2.88	2	63.5%	19.2%
Community Members as a Source of Information (7-point rating scale: 1 = most of the important information came from community members; 7 = ... non-community members); n = 44	3.70	3	47.7%	29.5%
Friendship status (7-point rating scale: 1 = most of the important information came from initially close friends; 7 = ... initially strangers); n = 53	3.30	3	32.4%	11.4%

5.2 Skills of Those Who Gave Assistance

Most innovators report receiving assistance from individuals who are creative and innovative, possess skills complementary to their own, and often have expertise that was useful in developing the innovation (Table 6).

TABLE 6: Skills of Those Who Give Assistance

Variable	Mean	Median	High Agreement	Low Agreement
Creative & Innovative "The people who helped me are creative and innovative themselves" (7-point rating scale: 1 = very accurate; 7 = not accurate at all); n = 53	2.11	2	71.7%	1.9%
Complimentary Skills "The people who helped me have skills that are complementary to mine" (7-point rating scale: 1 = very accurate; 7 = not accurate at all); n = 53	2.15	2	71.7%	0.0%
Expert Status (7-point rating scale: 1 = most of the important information came from experts; 7 = ... non-experts); n = 53	3.09	3	41.5%	7.6%

If those who give assistance are in fact as creative and innovative as innovators report, we should observe innovating behavior among those who assist. We do indeed find statistically significant evidence to support this: of the 41 individuals who gave assistance, over two-thirds were also innovators (Table 7). And, of the 60 innovators, almost half gave assistance to others.

TABLE 7: Relationship Between Innovating and Giving Innovation Related Assistance

	Innovators	Non-innovators	Total
Gave Assistance	28	13	41
Did Not Give Assistance	32	115	147
Total	60	128	
$n=188$; $\chi^2 = 31.93$; $p < 0.0001$			

The high satisfaction expressed by innovators who received help, the highly regarded skills of those who gave assistance, and the relatively high number of individuals taking part in assisting

and/or innovating activities (38.8%) shows that the system of mutual help in the communities works well.

6.0 Findings: "Community-Based Innovation Systems"

In this section we explore why community members assist innovators in developing their innovations for free. We show how both individuals and the community as a whole benefit from providing the innovator with free assistance and information, and from the free-revealing of the innovations to the community. We interpret these findings through the lens of social-exchange theory and argue that a system based on the concept of generalized exchange underpins the "community-based innovation system" we observe. We also show how competition lessens the likelihood of assistance and innovations being freely revealed.

6.1 Assistance is Freely Given

Community members who provided innovators with innovation-related assistance were rarely paid for their assistance and believe that community members should assist each other free of charge. In Table 8 we report some descriptive statistics regarding the reasons for giving assistance and present the results of a factor analysis conducted to better understand the underlying structure of the data.[5]

[5] We identified possible motivations for assisting by conducting exploratory qualitative interviews at the beginning of the study; we chose the eight most promising to be included in the questionnaire (Table 8). In order to better understand the structure of the relationships between these possible motivations we performed a principal component analysis. To determine the number of factors we followed the method of Horn (1965) who proposed to extract all factors that have an Eigenvalue that is higher than the highest Eigenvalue of a factor analysis of random numbers. The frequently used Kaiser criterion suggests that all factors with an Eigenvalue > 1 be extracted. This is likely to overestimate the "true" number of factors as was shown by Lee and Comrey (1979) and Zwick and Velicer (1986). To rule out the probability of meaningless factors we compared the Eigenvalues of our factors with the Eigenvalues drawn from a sample with random numbers (8 variables, 1000 cases). The results clearly advised us to extract two factors.

TABLE 8: Reasons for Giving Assistance Within the Community

Rank	Variable [a]	Descriptive Statistics			Principal Component Analysis [b]	
		Mean	Mean	High Agreement	Factor 1: Community Factor	Factor 2: Personal Benefit Factor
1	"It's my opinion that in a community, one should assist others"	1.48	1	92.6%	0.798	-0.157
2	"It's fun to create something jointly"	1.79	1	78.6%	0.582	0.225
3	"In my community there is the norm that members should assist each other free of charge"	2.11	2	74.1%	0.785	-0.323
4	"If I assist others today, I will receive assistance in the future"	3.11	3	35.7%	0.600	0.123
5	"I enjoy giving others advice as an expert"	3.28	3	32.0%	0.438	-0.219
6	"I wanted to use the product myself"	3.41	3	40.7%	0.082	-0.696
7	"It was nice to receive recognition"	4.61	4	10.7%	0.512	0.537
8	"I was paid well for my assistance"	6.39	7	7.1%	-0.097	0.833

[a] 7-point rating scale: 1 = very accurate; 7 = not accurate at all); n = 28 (individuals who provided assistance to others within the community)

[b] Factor Analysis: KMO = 0.517, Bartlett's Test of Sphericity = 0.000, Kaiser-Normalization, 51.6% Variance explained, Varimax Rotation

Community Based Motives vs. Personal Benefit Motives

The variables separate into two factors. We call the first factor the "community" factor because it includes the motivations and benefits that support the free sharing of assistance and information between community members. The assigned items contain the norm that assistance should be given freely ("one should assist others", "in the community there is the norm to assist each other free of charge") as well as the belief – related to both fairness and norms - that "if I assist others today, I will receive assistance in the future." In addition to this, the person who assists enjoys the process of creating something jointly ("it's fun to create something jointly", "I enjoy giving advice").

We call the second factor the "personal benefit factor" because it contains motives that emphasize receiving individually-focused benefits in direct exchange for giving assistance. These motives include receiving material rewards ("I was paid", "I wanted to use the product") as well as the psychological reward of being flattered, which may also lead to reputation effects ("It was nice to receive recognition"). All these items reflect direct reciprocal rewards an individual receives in exchange for his assistance.

The accuracy ratings (means) of the individual variables shows that respondents believe the community-factor variables to more accurately reflect their motivations for assisting than do the "personal benefit" variables.[6] Respondents view the variables related to the giving of free assistance (means of 1.48 and 2.11) and enjoying the innovation process (mean 1.79) as accurate reflections of their motivations for assisting. In contrast, the variables constituting factor 2 are viewed as much less accurate and, in particular, receiving financial compensation is clearly rejected as a motive (mean 6.39). This lends support to the idea that there is more than an assessment of direct personal benefit motivating assistance-giving behavior in these communities.

[6] The fact that the four most important variables and the three least important ones are grouped together is rather surprising and by no means a common pattern of the method. Principal component analysis is based on correlations, not on mean differences. Thus, variables with similar patterns are grouped and not variables with similar means.

The Impact of Competition on Assistance

The likelihood of giving away innovation related information may be affected by the level of rivalry within the community. If an innovator believes that revealing innovation-related information will allow a rival to outperform him, the likelihood that the innovator will reveal this information will decrease unconditionally. This hypothesis is clearly confirmed in the communities studied here: assistance is given less often in more competitive settings.

We compare the likelihood of assisting between the two less competitive communities (canyoning and sailplaning) and the two more competitive communities (boardercrossing and handicapped cycling) in our sample (Table 9). In the two less competitive communities, 21.7% of community members have assisted other community members on innovation projects; in the more competitive communities, only 6.7% assisted ($p<0.01$).[7] This makes sense as one would not want to help a direct competitor improve his performance. In spite of this, we still observe some free assistance being given in the high rivalry communities.[8]

TABLE 9: Impact of Rivalry Level on Assisting Behavior

Community	% of users who assisted other community members in innovation project
less competitive (sailplaning and canyoning); n = 129	21.7
more competitive (boardercrossing and handicapped cycling); n = 62	6.7
Difference	$p<0.01$[a]

[a] χ^2-test

[7] Even if we take into account that among the low competition communities more user innovations could be observed (34.7%) than in the high competition communities (19.7%) and thus the users have more opportunities to assist in a user innovation project, the difference is still striking. It can also be argued that the lower level of assistance and free sharing of important information in competitive surroundings causes these differences in innovative activities: because of less exchange there are less innovations.

[8] We find that the athletes who give assistance in the more competitive communities are not nearly as motivated by the prospect of having fun as are those who give assistance in the less competitive communities. But, there is no difference in motivations derived from the norms, financial motives, or the intention to use the innovation personally.

6.2 The Innovation is Freely Shared in the Community

We find that fully developed innovations – like assistance – are freely shared within the community and that the likelihood of free-sharing decreases as the level of competition within the community increases.

The Innovation is Shared – Not Sold – Within the Community

We observe that once the innovation (or part of it) is developed most innovators share it with the entire community free of charge (Table 10) – not just with the people who assisted. Innovations are virtually never sold within the community.

TABLE 10: Sharing of Innovation

Variable [a]	Mean	Median	High Agreement
The innovation is being used by many members of community	4.73	5	17.6%
Share(d) innovation free of charge within the community	2.63[b]	1	66.7%
Have sold the innovation to many inside the community	6.76[b]	7	0.0%

[a] 7-point rating scale: 1 = very accurate; 7 = not accurate at all); n = 40

[b] Difference in means between sharing the innovation free of charge and selling the innovation is significant $P<0.001$ (t-test for dependent samples)

The Impact of Competition on the Free-Sharing of the Innovation

We find that innovations are freely revealed within the community, but the likelihood of free-revealing decreases just like giving assistance with increased levels of competition within the community. There is significantly higher agreement with the statement "I shared my innovation free of charge" in the less competitive communities (Table 11).

Despite lower levels of free assistance and the free revealing of innovations, the community innovation system operates even in communities characterized by high rivalry conditions. In the highly competitive communities innovations assistance is given and innovations are freely revealed – just not as often as in the less competitive communities.

TABLE 11: Impact of Rivalry Level on Sharing Behavior

Community	Share(d) innovation free of charge within the community [a]	Have sold the innovation to many inside the community [a]	difference
Less competitive (sailplaning and canyoning)	2.05	7.00	$p<0.05$ [b]
more competitive (boardercrossing and handicapped cycling)	4.73	6.55	$p<0.05$ [b]
Difference	$p<0.001$ [c]	n.s. [c]	

[a] 7-point rating scale: 1 = very accurate; 7 = not accurate at all

[b] t-test for paired samples

[c] t-test for independent samples

7.0 Findings: Receiving Assistance Impacts Innovation Diffusion

Diffusion is an important element of innovation performance. It reflects the number of users interested in the innovation and the time it needs to win recognition among the users. The features of an innovation largely impact the extent and speed of its diffusion (Rogers, 1983). From a manufacturer's perspective, the extent of diffusion, combined with the amount of money each user is willing to pay and the costs of producing and selling, constitutes the profit a firm can expect from manufacturing the innovation.[9]

In this section we explain how we measure diffusion and show how the extent of diffusion within a community is a good proxy for the potential diffusion of the innovation both within and external to the community. Next we show how receiving assistance from the community impacts innovation diffusion: assistance is a necessary but not sufficient precondition for innovation diffusion.

7.1 Method: Measuring Innovation Diffusion

The extent to which an innovation has diffused is a measure based on information self-reported by the innovator. As an innovation may diffuse both inside and outside the community, we

[9] Diffusion is related to other measures of innovation performance. There are three other variables which can be regarded as partial measures of innovation performance, which we expect to be correlated with total diffusion: the newness of the innovation as assessed by the innovator ($r = 0.298$, $p<0.05$), the market potential of the innovation as assessed by the innovator ($r = 0.259$, $p<0.05$), and whether or not the innovation has yet been commercialized ($r = 0.368$, $p<0.01$). As shown, in our sample total diffusion is significantly correlated with each of these measures of innovation performance.

asked each innovator to report by how many users their innovation is used both inside and outside the community in two different questions (7-point rating scales).

Correlation analysis shows that an innovation used by many members of a community is likely to be used by many individuals outside of that community as well ($r = 0.579$, $p<0.001$, $n = 49$). Thus, the diffusion inside the community might be considered an early indicator of later diffusion outside the community. This high correlation allows us to aggregate these two scales two and construct a "total diffusion" index without suppressing major effects. This new variable (total diffusion) is our dependent measure of innovation diffusion.

7.2 Threshold or Linear Relationship?

Our findings suggest that receiving assistance from the community is a necessary but not sufficient precondition for innovation diffusion. This means that a threshold pattern, rather than a linear pattern, describes the relationship between the level of assistance by the community and the diffusion of the innovation.

In order to analyze the relationship between assistance and diffusion we perform crosstab analyses for different measures of assistance and diffusion. An example is displayed in table 12. The crosstab results for the level of encouragement received versus the diffusion displayed in Table 12 tell us that there is virtually no linear relationship between these two variables: there are almost no innovations along the diagonal of the crosstab and other forms of linearity are not visible. An OLS regression supports this point and shows that the linear relationship between the two variables is very weak and not significant.

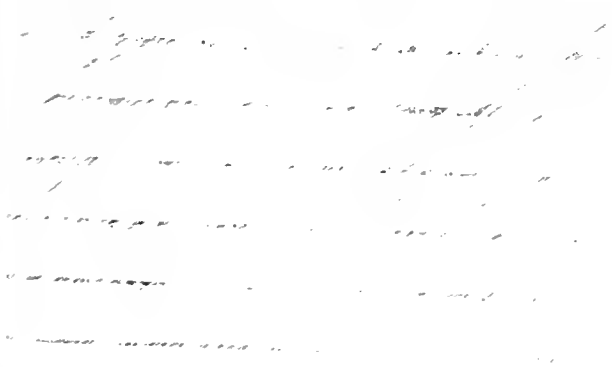

TABLE 12: Crosstab: Encouragement Received vs. Innovation Performance (Example)

	Diffusion of Innovation (total diffusion)						
Variable	High			Medium			Low
High level of encouragement received	1		1	1	2	2	3
	2	1			2	6	4
				1	3	2	3
Some support	1			1	1	2	3
						2	1
							1
No encouragement received				1		1	1

Summary of crosstab:

Position below diagonal: 5 innovations, above diagonal: 40 innovations, exactly on diagonal 4 innovations

Linear Regression analysis:

Coefficients: Encouragement: B = 0.219 (0.155), not significant; Constant: B = 4.665 (0.515), $p<0.001$

$R^2=0.041$, Adj. $R^2=0.020$, $F=1.988$, not significant, $n = 51$

A clear relationship does exist in the data in the form of a striking threshold pattern. Almost all data points (40 out of 49) are located above the diagonal (gray field); hardly any are on (4 out of 49) or below the diagonal (5 out of 49). Within the gray field, the data points are dispersed and do not show a clear pattern. It appears that the amount of assistance forms an upper bound for diffusion: the relationship is not "the more assistance, the better the innovation diffuses", but "assistance is necessary but not sufficient for innovation diffusion." This makes sense: assistance will improve the quality of an innovation to a limited degree, but even an unlimited amount of assistance will not turn a poor idea into a breakthrough innovation or turn an idea with limited consumer interest into a blockbuster.

We performed this analysis for other forms of assistance as well and find similar patterns (table 13). Results show clearly that assistance by the community does not "guarantee" diffusion, but less assistance might be associated with more limited diffusion. In reading the table, note that a clustering of cases along the diagonal would indicate a linear relationship, a clustering above the diagonal a necessary but not sufficient threshold relationship. Cases below the diagonal tell that the innovation diffused well although the innovator did not receive much assistance.

TABLE 13: Crosstab Summaries: Assistance Received vs. Innovation Diffusion

	Crosstab Analyses				
	Above diagonal	**Below diagonal**	**On diagonal**	**Regression Analysis**	
	interpretation: assistance necessary but not sufficient for diffusion	interpretation: diffusion is independent from assistance	interpretation: the more assistance, the better diffusion	interpretation: same as on diagonal crosstab analysis	
Variable					
More general activities:					
Most assistance came from community relative to outsiders	23	6	13	-0.180 (0.160)	n.s.
Community helped by serving as a network to others	30	6	12	-0.005 (0.165)	n.s.
Number of individuals giving assistance	27	7	14	-1.048 (0.316)	$p<0.01$
More specific activities:					
Frequency of testing and getting feedback	26	8	15	0.208 (0.115)	$p<0.05$
Frequency of getting assistance in technical details	39	3	7	0.139 (0.171)	n.s.
Frequency of talking about the problem	44	2	2	-0.229 (0.291)	n.s.
Frequency of getting advice and suggestions for improvement	41	5	2	-0.216 (0.218)	n.s.
Frequency of confirmation and encouragement	40	5	4	-0.129 (0.157)	n.s.
Total	270 (70.9%)	42 (11.0%)	69 (18.1%)	Note: coefficients are B-values, standard error in parenthesis Constant: B = 10.330 (1.860), $p<0.001$ $R^2=0.436$, Adj. $R^2=0.295$, $F=3.094$, $p<0.05$, $n=40$	

We find the threshold pattern to be prevalent in all variables we tested. Thus we can say that (1) more assistance coming from community members relative to outsiders, (2) the use of the

community as a network, (3) the number of assistants in the project, and (4) the frequency of all specific assistance activities that were provided, all have an "enabling" impact on total diffusion. More problems or potential improvements might be identified and solved when more people are involved[10], but if the innovative idea itself is unfeasible or too difficult to realize the assistance will not have an effect on the diffusion. Feedback from community members is more relevant than feedback from outsiders (as they might, for example, have a common favorite terrain or conditions in which they do their sport); this idea is somewhat parallel to the idea that the most relevant information an engineer can seek out is often found within his firm (Allen, 1984).

For two of the eight variables tested we also found a linear relationship with diffusion. (1) The higher the number of assistants and (2) the more testing and feedback the innovator received, the better the innovation diffuses. This means that these two variables have in addition to their enabling effect also a direct impact on innovation diffusion.

Two interpretations are possible on how the community assistance impacts innovation diffusion. The first is that assistance by community helps to improve the functionality and quality of the innovation and this leads to higher diffusion (assistance → quality → diffusion). From qualitative interviews we believe this effect to be the more important one. The second interpretation is that if people assist in an innovation, they already have some knowledge about the innovation, which may have a positive impact on its diffusion beyond the quality improvement (assistance → diffusion). However, we believe this is not the main effect.[11]

Altogether, these findings strongly confirm our interpretation that community supports user innovation. Not only do innovators have a stronger relationship to the community than do non-innovators and receive assistance in every case in our sample; but the relative amount of community interaction impacts the diffusion of the innovation, with assistance being a necessary, but not sufficient condition for innovation diffusion.

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[10] "Given enough eyeballs all bugs are shallow (Raymond, 1999)" illustrates this idea in the case of open source software development.

[11] Also a reversed causality cannot be fully precluded. In some cases a person might actively offer his assistance if he thinks the innovative idea is very promising and of use to himself. In other cases a person might refuse to help if he thinks the idea is hopelessly stupid or cannot be carried out at all. These cases would indicate a causality "quality → assistance → diffusion". Due to the cross-sectional data we cannot analyze from the data itself which interpretation is correct. However, qualitative insights from interviews fortify our belief that the explanation " assistance → quality → diffusion" offers the best interpretation.

8.0 Discussion

8.1 Community-Based Innovation Systems: the Foundation for "Open Sources" of Sports Innovation

Studies of the innovation process often focus on firms and groups within firms. In this paper we describe an alternative form of organization that also produces valuable products: a „community-based innovation system". Behavioral patterns reflecting the free-revealing of assistance, information, and innovations are central to innovation in the communities we study. Briefly, these patterns include, but are not limited to, the finding that community members - who may or may not be innovators themselves - often provide assistance to innovators without pecuniary reward, even when they are not interested in using the innovation themselves; that reputation does not appear to be a significant motivator for those who give assistance; and that innovators generally freely share their innovations both inside and beyond the community, with higher intra-community competition associated with a lower level of sharing. We argue that a system based on generalized exchange exists within these communities and that this mode of exchange helps explain the behavioral patterns we observe. This community-based system provides the user-innovator with information, assistance, and links to other individuals; simply put, it provides the innovator with access to resources. In contrast, innovators in firms access such resources through the firm at large, through product development teams and other structures within firms, or through sources external to the firm.

We showed in section 6.1 that those who provided assistance in these communities were motivated by more than personal benefit alone; in fact, motivations related to personal benefit received the least support from survey respondents. The strongest motivations for assisting reflected social processes - enjoyment gained from working with others, the presence of community norms supporting providing assistance for free, and the idea that helping others in the community is what should be done (which may in turn reflect altruistic feelings towards others, norms, or the presence of a fairness-based generalized exchange mechanism in the community). Community matters not only in the direct provision of resources for innovation development, but it also influences the process by which these resources are shared and exchanged.

The second "big" piece of the behavioral puzzle has to do with why innovators often distribute their innovations for free. We believe that they do this largely in order for themselves as well as the community to benefit from collective invention (see "Collective Invention" in section 8.2), and that this behavior also serves to reinforce the idea that sharing - whether of assistance or innovations - is of collective importance in promoting generalized exchange within these communities.

8.2 Why a Community System and Not a Market System?

Our data clearly shows that, within these sports communities, innovation related assistance and information is given for free, as are the actual innovations. These communities clearly do not operate as markets in which innovators pay for the assistance they receive – instead, a community-based system appears to be an effective form of organization within these user-communities. In this section we explain why we think this is the case. In brief: a community-based innovation system compared to a market system seems to offer significant advantages.

Difficulty in Placing a Value on Assistance and Information

One reason a market system might lead to significant disadvantages and might even inhibit the exchange of innovation related assistance is that it may be difficult or impossible to value the information that is being shared in the context of its potential use – it is often not known if a functioning prototype will be developed, if the product will be used by even one individual, if the product will be used by many, and what the value of the product will be for those who use it. In addition, the perception of the individual who has the information and the individual who needs the information might differ. Thus, the process of finding and negotiating a price could induce prohibitive transaction costs.

The Effect of Intrinsic Motivation on Innovation-Related Activities

Another reason favoring community systems over market systems in the context of the user-innovation process is related to intrinsic motivation. It has been found that if activities are rewarding in and of itself, individuals may perform the activity, as well as exchange information and assistance related to that activity, even in the absence of financial or other types of rewards

(Amabile 1983; Cziksentmihalyi, 1996). Challenge and mental stimulation, control, curiosity, and fantasy are all likely to enhance and individual's intrinsic motivation towards an activity (Malone & Lepper, 1987); these elements are very prevalent in innovation-related activities. On the other hand, adding a financial or other type of reward for engaging in an activity may decrease an individual's intrinsic motivation towards that activity. Such shifts in motivational orientation from intrinsic to extrinsic have been shown to negatively affect the nature of interpersonal interactions (Pittman, 1982, 1992) and decrease creativity (Amabile, 1985). A market based on restricted exchange or external rewards might decrease the innovation-related benefits of intrinsic motivation.

Communities Guard Against Free-Riding

Theoretically, one major disadvantage of a voluntary community system, as compared to a market system, is that it is vulnerable to opportunism and free riding. It is argued that it pays for a person who received some important assistance in the past (and thus has a "net gain") to reject to pay his part back if he is asked to give assistance. In response, generalized exchange theorists have introduced the concepts of norms, altruism, and fairness-based selection mechanisms (see literature review). By not assisting, an individual may violate community norms and be reprimanded or penalized, and in an extreme situation be excluded from the community (Turner and Killian, 1957). On the other hand, by not assisting, an individual may be viewed by others in the community as someone who does not "play fair" and thus increase his likelihood of being denied help when he needs it (Takahashi, 2000). Qualitative interview data from other fields of sports as well as open source communities indicates that an individual is unlikely to be punished for not assisting, but that they may not receive help when they ask for help or receive "less help" (in quality, time allocated, priority, etc.) than someone who played fair might receive.

"Appropriation" of Rents by User-Innovators

We show that innovating users often freely-reveal their innovations both within and outside the community; one might wonder how the innovating-user benefits from his labor if he does not sell his innovation. The innovating users generally do not benefit financially from their innovations; in fact, it appears that they derive few benefits beyond those generated from in-house use. This pattern fits findings regarding the significant costs and low probability of success associated with

efforts to protect and license intellectual property in many fields (Taylor and Silberston 1973, von Hippel 1988, Shah 2000).

One might ask if it is appropriate for another party to profit from an innovator's work if the innovator has chosen to freely-reveal it. In our sample, 23.1% of innovators report that their innovation has been or is likely to be commercialized by a third-party. It appears that user-innovators and developers are willing to share their innovation for free and also want to make sure that their work remain "free" for use by anyone; although in some cases, commercial entities may begin producing the innovation for sale as well, especially in fields with a weak intellectual property regime. In OSS communities, the innovations are free for non-community members to use as and licenses such as the GNU Public License, the Mozilla Public License, and others (see opensource.org) are an important part of the system. One of the functions of the license in this context is to guard against the appropriation of the innovation or work by another individual. There are no such licenses in the domain of sports-innovations and the likelihood of appropriating rents through patenting or licensing is weak for a variety of reasons (Shah, 2000). However user-innovators often published designs for their innovations and directions for how to construct them in well-read journals - thereby, in essence, making the information freely (at the cost of purchasing or buying a magazine) and openly available.

Collective Invention

In addition, users may derive many benefits from revealing (and not selling) their innovations to the community as a whole. These benefits might include psychological benefits derived from engaging in altruistic actions (Staub, 1977) as well as inducing further improvements to the innovation by users as well as manufacturers – improvements that benefit the innovators as well as other users (Allen, 1983). This mechanism is also considered to be a driving force of the free revealing of user innovations in open source software (Raymond, 1999).

Also consider the following possibility: an innovator may not be concerned about the possibility of others "free-riding" and using his innovation, this is especially true of an innovator who can not or chooses not to commercialize his innovation himself. In that case, freely-revealing would create no negative consequences for the innovator, while increasing the likelihood of further

improvements, standardization, and adoption of the innovation – and be seen as the most sensible behavior.[12]

8.3 Similarities and Differences to Open Source Software (OSS) Communities

The parallels between these end-user sports communities and open source software communities are striking. Like in OSS communities, members of the sports communities voluntarily come together and engage in innovative activities that advance the sport. Within the sports communities, like OSS communities, smaller and often very informal "groups" form around specific innovations or software modules. Assistance is given freely and the resulting innovations are also freely revealed. The innovations that result from these processes appear to perform very well and are used by individuals both inside and outside the community. In both sports and OSS communities, we do not observe market systems in which direct reciprocal exchanges occur, but "community-based innovation systems" in which exchange can be explained by the idea of generalized exchange.

Apart from the obvious difference that sport communities produce physical products and are geographically concentrated, while OSS communities produce software code and are geographically dispersed, there are many other differences as well. Innovation and the advancement of the sport are not the only objectives of the sports communities; many members simply enjoy the company of others while practicing the sport. Innovation and product development are the core reasons for the existence of OSS communities. Perhaps because innovative activities are not necessarily the central objective of the community it is understandable that in sport communities these activities are not coordinated by a core group of people as they are in OSS communities. OSS communities appear to be much more "governed" and hierarchical in terms of the methods by which disputes are resolved and development pathways are laid out, than do the sport communities. This difference may exist for one of many reasons: the size and geographic dispersion of the communities, the importance of standards and version control, or it may be the case that product specific characteristics make it unnecessary to coordinate efforts.

[12] The authors are indebted to Carliss Baldwin and innovators Larry Stanley and Mike Horgan for this idea.

Sports equipment innovations are physical objects, while OSS is an information product that can be distributed by users at no cost. This has significant consequences for manufacturers. OSS is often viewed as a challenge to the future existence of traditional software firms (Raymond, 1999). A physical innovation in sports equipment, on the other hand, can only diffuse widely if a manufacturer produces it for sale, the innovation is easy for consumers to produce themselves, or if an innovator begins producing his innovation on a scale large enough to satisfy market demand. Manufacturing is in this sense complimentary to product innovation occurring in sports communities and firms are needed to undertake this activity; however manufacturing is not important in the software firms and the product development skills of a software firm is largely a substitute for product development in OSS communities. A manufacturer can use these insights to improve his product offerings.

8.4 Implications for Managers/Manufacturers

Firms interested in developing new products often rely on internal R&D laboratories and market-research to come up with ideas for new products; these ideas or the resulting prototyped products are often then evaluated and tested by representative samples of consumers. This process is used by many firms, but has its shortcomings. Firms may miss new and upcoming product ideas because of their own screening techniques. Firms who want to avoid such traps should add the monitoring of user-innovations in some innovative communities to their product development-related-activities. Employing this method offers the benefit of getting information about upcoming promising user innovations very early and at very low costs.

When it comes to selecting one or some promising communities, conventional wisdom suggests picking the most professional community – for example, world cup racers in the case of a ski manufacturer. However, professionalism often goes together with competition and competition decreases the free flow of innovation information. Looking at a professional, but not extremely competitive community may make more sense – for the ski manufacturer, contacting e.g. a community of ski fanatics in the most demanding region of Colorado who face extreme conditions and have found ways to make skiing in such conditions fun, but face less rivalry might provide better insights in user innovations.

It is not necessary to screen every member of the communities, let alone the whole market, for promising user innovations. Getting information from some few central members regarding new

ideas and new innovations in the specific market provides an excellent tool for the early detection of promising user innovations. Our findings indicate that members who are more central to the community are more likely to innovate themselves and will also have an exceptionally good knowledge of user innovations developed by other community members – especially since user innovations are revealed freely and promising innovations are diffused widely within the community. This "networking-technique" is likely to provide the manufacturer with exciting information about useful and novel user innovations at a small fraction of the cost of a complete user screening effort.

The manufacturer can then decide whether to commercialize the user-developed innovation based on its own manufacturing and marketing abilities as well as innovation-specific characteristics such as the ability to patent or license the innovation[13], safety, ability of users to build the innovation themselves, willingness to pay, and cost to produce. In this way, manufacturers keep in touch with the market; make use of their marketing, sales, distribution, and manufacturing skills; and avoid falling into a trap where their own screening devices and metrics cause them to miss major market developments.

9.0 Suggestions for Future Research

This study provides an overview of the processes at work in "community-based innovation systems." In the course of this research, we uncovered many interesting puzzles and questions some of which we were able to investigate in detail and some of which we now propose as suggestions for future research in this highly exciting area.

Four sets of empirical questions stand out. (1) A better understanding of how users share innovation related assistance and complete innovations under different conditions - such as increased competition, "non-voluntary" communities, or communities in which a strong structure or hierarchy exists - is needed. (2) More research is needed to better understand what types of information and assistance are likely to be exchanged under varying degrees of competition. We

[13] It is important to remember that the free-revealing and sharing of innovations is important in these communities. While an innovator may not mind a manufacturer producing an innovation for individuals who are unable or unwilling to build it themselves, they might object to aggressive patenting, excessive price mark-ups above cost, or not giving the innovator credit for developing the innovation if the identity of the innovator is known. More research on this area is needed.

propose three factors which may play a role: (a) assistance is likely to be given freely for innovations which do not directly affect performance and instead improve other factors such as safety, (b) even within competitive communities, there are likely to be smaller groups which are close-knit and provide assistance to one another, (c) the athletes may separate into tiers in ability and be more likely to provide assistance to those who are not close to their own ability level. (3) A deeper understanding of the social structure underlying user-communities might be obtained through a social network analysis of user-communities: specifically, how do innovators and those who give assistance find one another, how do the social networks develop and evolve, what is the relative importance of skill level versus pre-existing relationships in determining an individuals position in the network, etc. (4) The question of how these community-based user innovation systems are initiated and evolve has yet to be addressed, as does the question of what happens if the shared practices of giving free assistance and freely revealing innovations are breached.

10.0 Conclusion

In this study we show that the pattern by which innovations are developed and freely revealed is not exclusive to software products and can also be observed in the world of physical products. We provide insight into the structure of the user-communities in which this behavior is prevalent. We believe the findings of this study to be quite generalizable; but formal studies in other consumer or industrial markets are necessary and many exciting questions have yet to be addressed.

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Appendix: Sample Questionnaire

Below, you'll find a shortened version of the questionnaire distributed to members of all four sports communities. The sample refers to the Boardercross community in particular.

A. Sports community

How long have you been a member of the Boardercross community? [open]; How long have you been participating in Boardercrossing? [open]; On how many days per year do you participate in this sports? [Approximately [open] days total, of which approximately [open] days are spent with the Boardercross community].

Please tell us more about your involvement with Boardercrossing community. Items: "I get together with members of the Boardercross community for activities that are not related to Boardercrossing (movies, dinner, parties, etc.)", "The Boardercross community takes my opinion into account when making decisions." "I am a very active member of the Boardercross community." [each 7-point rating scale]

B. Own ideas for improved or new [adaption to specific sport] products

Have you improved existing products or had ideas for new products that were not offered on the market before? [yes/no]; Please briefly describe your product idea/improvement [open]; Please rate your product idea/improvement on the following dimensions: newness, urgency, market potential [each 7-point rating scale].

Products are often developed by individuals working together. Often one receives assistance from other people (advice, use of resources, etc). We are interested what it was like with your product idea/improvement. Items: "Talking with others about the problem that should be solved was of assistance to me."; "Others assisted me by giving competent advice and suggestions for improvement."; "Others assisted me by advising on technical details."; "Others assisted me by testing and giving feedback."; "The confirmation and encouragement of others was of help to me." [each 7-point rating scale]

If others assisted you, we would like to know more about it. Most of the important information and assistance came from ... [7-point rating scale: community members vs. non-community members; initially close friends vs. initially strangers; experts vs. non-experts]; "Belonging to the

Boardercross community helped me find people who contributed to my product idea/improvement." [7-point rating scale]; How many people, other than yourself, have assisted you in your product idea/improvement? [zero, 1, 2, 3-5, 5-10, more than 10]

Which statements apply to the people who assisted you with your product idea/improvement? Items: "The people who assisted me are creative and innovative themselves."; "The people who assisted me have skills that are complementary to mine."; "If I had a similar problem I would ask the same people again." [each 7-point rating scale]

New product ideas/improvements often are interesting to many people. We are interested what you have done to let others know of your product idea/improvement. What have you been doing? Items: "I share(d) my product idea/improvement with the [adapted to specific community] community free of charge or at cost." "I have sold my product idea/improvement to many members of the [adapted] community." "I share(d) my product idea/improvement with individuals outside the [adapted] community free of charge or at cost."; "I have sold my product idea/improvement to individuals outside the [adapted] community"; "The product idea/improvement is used by many members of the [adapted] community", "The product idea/improvement is used by many individuals outside the [adapted] community" [each 7-point rating scale]; Has you product idea/improvement been produced for sale by a manufacturer or will it be in the foreseeable future? [yes/no]

C. Your Assistance with ideas from others (for improved or new Boardercross products)

Have you assisted another Boardercrosser who developed ideas for new or improved products (that were not offered on the market before)? [yes/no]; If yes: Please briefly describe the product idea/improvement [open]; The person who I assisted can be characterized as ... [community member or Non-Community member]

There are numerous reasons for assisting others in their projects. Why have you been assisting them? Items: "I wanted to use the product idea/improvement myself." "If I assist others today, I will recieve assistance in the future."; "I was paid well for my assistance."; "It was nice to receive recognition." "It's fun to create something jointly."; "It is my opinion that in a community, one should assist others."; "In the Boardercross community there is the norm that